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LONG-TERM EVALUATION OF DURABLE LANE DELINEATION MATERIALS

by

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16. Abstract

The objective of this report was to summarize the long-term performance of several types of durable lane delineation materials. Polyester paint was determined to be an effective durable lane material with most use of this material being on asphaltic concrete surfaces having an average daily traffic of under 10,000. Extruded thermoplastic was also determined to be an effective durable lane delineation material with its cost limiting its use to higher volume asphaltic concrete surfaces. Either the hydrocarbon or alkyd thermoplastic formulation could be used but the alkyd formulation was observed to maintain a higher reflectivity. While not classified as a durable marking material, water-based paint could be used as an alternative to alkyd traffic paint.

The 3M 350 Series Stamark tape was judged as being an effective lane delineation material, but its cost would limit its use to specific areas such as high volume roads having a portland cement concrete surface.

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Lane Delineation	Extruded Thermoplastic	Unlimited with approval of the Kentucky Transportation Cabinet
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Durability	Preformed Tape	
Appearance		
Polyester Paint		

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Executive Summary

LONG-TERM EVALUATION OF DURABLE LANE DELINEATION MATERIALS

The objective of this report is to summarize the performance of large-scale installations of several types of durable lane delineation materials that had been in service for an extended period of time. The materials evaluated included polyester paint, extruded thermoplastics, water based paint, and preformed tape.

Data collected consisted of daytime observations of the appearance and durability of the material along with reflectivity measurements using a portable retroreflectometer (Mirolux 12 PRR). A colormeter was used to give an objective rating of the appearance of the material.

The long-term evaluation of polyester paint indicated it to be an effective durable lane delineation material. To maximize its effectiveness, it was recommended that this material should be used on asphaltic concrete surfaces having an average daily traffic of under 10,000. The data show that polyester paint should provide a service life of at least three years and, given the contract cost of 7 to 8 cents per linear foot, it would provide a cost-effective material.

The long-term evaluation of extruded thermoplastic indicated it to be an effective durable lane delineation material. It should be used on bituminous pavements with its cost limiting its use to higher volume highways. Either the hydrocarbon or alkyd formulation could be used, but the alkyd formulation has been observed to maintain a higher reflectivity.

While this evaluation did not yield information which would classify water-based paint as a durable lane delineation material, its performance indicated that it could be used as an alternative to typical alkyd traffic paint.

The long-term evaluation of the 3M 350 Series Stamark tape revealed that it was an effective lane delineation material, but its cost would limit its use. An appropriate use would be on high volume roads having a portland cement concrete surface.

INTRODUCTION

A previous study evaluated several types of durable lane delineation materials and recommended expanded use of polyester paint and extruded thermoplastics (1). There were large-scale installations of polyester paint placed across the state in 1986 and 1987, and extruded thermoplastic material was placed on interstates having open-graded asphalt surfaces in 1986. Results from the first 18 months of service of the extruded thermoplastics have been reported (2). An objective of this report was to summarize the performance of the polyester paint and extruded thermoplastics installations after periods in service ranging up to three years.

Also reported is the performance of preformed tape and extruded thermoplastic markings which were placed on Interstate 65 (I 65) in Jefferson County. The performance of installations of water based paint which were placed in 1988 in one highway district is also discussed.

INSTALLATIONS

POLYESTER PAINT

These installations were placed by contract and consisted of applying lane lines, edge lines, and centerlines on selected sections of highway across the state. All of the lines were four inches in width. The majority of the roads were two lane but there were also four-lane roads included. Almost all of the paint was applied to asphalt pavements but there was a limited amount placed on portland cement concrete (concrete).

The polyester paint was applied at a thickness of approximately 15 mils. The bead application rate was about 20 pounds per gallon. The no-track time varied with air temperature but was usually about 15 to 20 minutes such that coning was necessary. No-track times as low as five minutes were noted in hot weather.

The lines installed in 1986 totalled approximately 3.6 million linear feet of four-inch white and yellow line at a cost of 6.5 cents per foot. In 1987, approximately 4.3 million linear feet of markings were placed at a cost of 7.2 cents per linear foot. A total of approximately 250 miles of road were striped under the 1986 contracts with about 277 miles striped in 1987.

Installations of the polyester paint were monitored and discussions were held with both state inspectors and the contractor. Samples were obtained, and it was determined that the bead embedment and bead distribution were good. An inspector noted that the thickness was checked periodically with a gauge and the speed of the striper was adjusted if the thickness deviated from the 15-mil thickness. The contractor noted that the amount of paint used was metered and the quantity used per mile was determined to check the application rate. A striping speed of about 12 mph was used. The old stripe was cleaned with a motorized brush before placing the polyester paint. The high rate of beads applied was achieved with a modified bead gun.

EXTRUDED THERMOPLASTICS

The extruded thermoplastics were placed in 1986 on interstate highways having open-graded asphalt surfaces. Four separate contracts were awarded (two using an alkyd formulation and two using a hydrocarbon formulation). The cost per linear foot for a four-inch line varied from approximately 19 to 22 cents for the alkyd and 18 to 20 cents for the hydrocarbon formulation. The total quantities for the four contracts were approximately five million linear feet of four-inch line for white lane lines and yellow edge lines and 76,000 linear feet of eight-inch white line for gore markings. The quantities for the alkyd formulation were about 2.8 million linear feet of four-inch line and 47,000 linear feet of eight-inch line. The quantities for the hydrocarbon formulation were about 2.2 million linear feet of four-inch and 29,000 linear feet of eight-inch line. The projects covered about 214 miles on five different interstates with 115 miles of alkyd formulation and 99 miles of hydrocarbon formulation.

Lane lines and edge lines were four-inch lines and gore markings were eight-inch lines. Lane lines were installed as a ten-foot segment of material with a 30-foot gap. Due to the possibility that water may be retained on the roadway by the edge lines, a one-foot gap was placed every 20 feet.

The thermoplastic material was extruded using a shaping die and placed at a minimum thickness of 90 mils. It was not placed when the pavement temperature was below 50 degrees Fahrenheit or when the surface of the pavement contained evidence of moisture. On portland cement concrete pavements (bridges), a binder/sealer was applied to the area where the thermoplastic marking materials were placed. If it was felt that the existing pavement marking was loose and flaky, this material was removed by grinding or sandblasting. This was not a problem on the open-graded pavement but was a consideration on the concrete bridges.

In each contract, it was stated that the material must conform to AASHTO Designation: M249-79. The yellow pigment contained a minimum of four percent encapsulated, heat resistant lead chromate. The application of glass beads was at a minimum rate of four pounds per one hundred square feet of line applied at the time of line placement. The only difference between the specifications of the alkyd and hydrocarbon formulations was the addition of a paragraph pertaining to "binder composition" in the material specifications section. This paragraph stated that: "The solid resin shall comprise a minimum of eight percent by weight of the entire material formulation which shall only consist of one hundred percent maleic modified glycerol ester of wood rosin with no tall oil derivative. Properly formulated maleic modified glycerol ester of wood rosin alkyd thermoplastic will, when one hundred grams of the sample is melted and mixed thoroughly with ten grams of Quaker State non-detergent thirty weight motor oil to approximately 425 degrees F., remain hard after pouring into a shallow lid or a thin patty and upon cooling shows a definite separation of the oil as a distinct layer on top of cool thermoplastic".

Installations under the various contracts were monitored during the summer and fall of 1986 and discussions were held with both the state inspectors and contractor. The thermoplastic material was placed using a four-vehicle caravan,

including the striper, with all vehicles equipped with an arrow board. No coning was required. There was a 30 second to one minute no-track time and no problems occurred with tracking. It was noted that the bead application rate was higher than required by the specifications. This was done to increase reflectivity. Two bead guns were used with the beads sprayed under pressure. It was noted that if the temperature of the material was too high the beads would sink but if it was too low, the beads would not embed properly and would be knocked off by traffic. Checks at several locations revealed that bead embedment was good. The inspectors noted that stripe thickness was monitored with the 90-mil minimum thickness maintained in most instances. The contractor noted that the hydrocarbon formulation material was easier to work with than the alkyd formulation. On the portland cement concrete bridges, the old paint was removed by grinding and a primer was used, but no surface preparation was necessary on the open-graded pavement since very little paint remained. Care had to be taken in the screening process to insure that clumps of material would not be placed. On a newly resurfaced open-graded surface, more thermoplastic material was required to obtain the 90 mil thickness since the aggregate had not been worn down and more voids had to be filled. On a section of pavement which had been resurfaced only about two weeks before placement of the thermoplastic, oil from the pavement was drawn through the thermoplastic to the top resulting in a number of small oil spots on the surface. While this did not present an appearance problem while driving down the roadway, the contractor noted that this problem could be solved by paint striping to seal the oil before placing the thermplastic.

An installation of alkyd extruded thermoplastic placed on I 65 in Jefferson County on portland cement concrete pavement was also observed. This installation was made in 1987. This was a relatively small-scale installation of 85,294 feet of four-inch line and 12,140 linear feet of eight-inch line. The cost of about one dollar per linear foot for the four-inch line and $2.50 per foot for the eight-inch line shows the effect of the quantity placed.

WATER-BASED PAINT

Water-based paint was placed in 1988 in one highway district. Only yellow paint was placed. The district's paint striper was modified so that the paint could be placed with Transportion Cabinet personnel. The cost for the water-based paint was about $5.00 per gallon compared to a cost of about $3.50 per gallon for the typical alkyd traffic paint.

No cones were used since the drying time was determined to be as good as with the regular traffic paint. There were no problems with tracking. The bead embedment was reported to be good. A disadvantage was that the paint can not be stored outside unless the temperature is above freezing. The storage limits the length of the striping season. It was also noted that, if a rain occurred on the paint a short time after placement, the paint could be lost or damaged. It was reported that the striping crew liked to use this paint. A major advantage is the environmental aspect that air pollution is reduced by using water-based paint.

PREFORMED TAPE

Two types of preformed taped were installed on sections of I 65 in Jefferson County. The first installation was 3M Series A350 Stamark Pliant Polymer tape which is 60 mils thick. This tape was installed in 1986 and evaluated over a three-year period. A total of 147,501 linear feet of four-inch white and yellow line was placed at a cost of $1.15 per linear foot. A total of 5,900 linear feet of eight-inch white line was placed at a cost of $2.60 per linear foot. The section of I 65 on which the tape was placed consisted of a combination of asphalt and portland cement concrete surfaces.

The second type of preformed tape was a tape manufactured by Prismo which was 90 mils thick. This tape was installed in 1987 and 1988. A total of 79,883 linear feet of four-inch white and yellow line was placed at a cost of $1.78 per linear foot. A total of 10,185 linear feet of eight-inch white line was installed at a cost of $3.45 per linear foot. The section of I 65 on which this tape was placed consisted of a new portland cement concrete surface. The surface was sandblasted and primed before placement of the tape.

DATA COLLECTION

Data were collected up to three years after installation. Data were obtained periodically to determine how the material performed over time.

Data collected consisted of daytime observations of the appearance and durability of the material along with reflectivity measurements using a portable retroreflectometer (PRR). The appearance evaluation considered color of the white or yellow lines as compared to their original color and as compared to desirable colors. This was done by observing the stripes while driving on the roadway as well as by viewing the stripes at a distance of a few feet. The appearance evaluation also concerned cleanliness of the stripe. The durability evaluation considered the ability of the material to remain on the surface. Observations were made to determine if there were adhesion problems resulting in a loss of bond between the material and the roadway surface or if the material was being worn off the road by traffic. A subjective judgement of the percentage of material remaining on the surface was made. The Mirolux 12 PRR was used to collect the reflectivity data. In early 1987, the Mirolux 12 was adapted so that measurements were in terms of millicandelas per square foot per foot-candle (millecandelas). Only measurements in millecandelas are reported. A colormeter (Colorgard 11 Reflectometer) was purchased in 1989 to give an objective, rather than subjective, rating of the appearance of the materials. The measurements obtained with the Colormeter are dimensionless and were used to compare the various materials. These data are reported for the 1989 data collection period.

Nighttime observations were also conducted. Both daytime and nighttime photographs were obtained to document the durability, reflectivity, and appearance evaluations.

Data were collected on several sections of roadway with any given type of delineation material during each observation period. Several measurements and

observations were made on each section. The PRR and colormeter data presented are an average of the data collected on the roadways listed.

RESULTS

POLYESTER PAINT

Appearance

The appearance of the white polyester paint was not as bright in color as a typical traffic paint. This would be partially related to the large amount of beads used with this type of paint. However, its daytime appearance was judged to be adequate when viewed while driving on a road. The appearance of the yellow paint would also not be considered a bright yellow. The yellow was also judged to be adequate. The appearance of the stripes was maintained over the evaluation period. The colormeter measurements for the white stripes were generally in the range of 35 to 50 while the yellow stripes yielded typical readings of 20 to 30.

Durability

The majority of the polyester paint locations were restriped in 1989 with typical traffic paint after two to three years in service. The paint was worn to the point that it needed restriping at some high-volume locations, especially in urban areas where there was a large number of turning vehicles and at some locations where the lane width was narrow. Other locations were restriped as part of the restriping schedule although there was no durability problem.

There was a limited amount of loss of the paint due to lack of adhesion although this was not a substantial problem. The limiting factor for the length of time this paint could remain in service would be related to the amount and type of traffic. In urban areas, there was a loss in durability on roads having an ADT of over about 10,000 after a couple of years. On rural roads or roads having a typical lane width and a limited amount of turning traffic, there was no durability problem after three years in service even when the ADT was over 10,000.

The majority of the installations was on asphalt pavements. There were a few sections of portland cement concrete pavement and the durability results were not as consistent as on asphalt. Polyester paint was observed to perform very good on some sections of portland cement concrete pavement. For example, it was placed in 1987 on a section of portland cement concrete pavement on I 65 in Hardin County having an ADT of about 26,600, and no durability problem was noted after two years in service.

Reflectivity

Measurements were obtained with the Mirolux 12 PRR at a sample of locations from 1987 through 1989. The PRR data are shown in Tables 1 and 2 for the highways striped in 1986 and 1987, respectively. The location and ADT for that location are given along with the PRR reading for the white edge line, white lane line, or yellow centerline.

The locations which sustained a large decrease in reflectivity were urban locations having either narrow lane widths or high turning volumes. Examples would be US 431 in Daviess County at milepoints 13 and 14 which are in Owensboro. The PRR reading remained above the approximate minimum of 100 millicandelas at the majority of locations after two to three years in service.

EXTRUDED THERMOPLASTICS

Appearance

The daytime appearance of both the white and yellow stripes when viewed by driving on the road remained good over the three-year period. When viewed from a few feet, some of the white stripes did not retain a bright white color but any appearance of a gray color was not readily observable while driving. The yellow stripes maintained a bright yellow color.

Colormeter data were obtained during the "three-year after" data collection period. The average colormeter measurements for the hydrocarbon formulation were 50 for the white edge line, 41 for the white lane line, and 37 for the yellow edge line. This compared to 45 for the white edge line, 40 for the white lane line, and 37 for the yellow edge line for the alkyd formulation. The colormeter data were slightly higher for the hydrocarbon compared to the alkyd formulation. The measurements for the white stripes were similar to that noted for the polyester paint while the readings obtained for the yellow stripes were higher than that noted for the polyester paint.

Durability

After the three-year evaluation period, only two sections of markings had been striped. A section of the alkyd formation thermoplastic markings on Interstate 71 was restriped in late 1989 after three years in service. This 39-mile section was restriped with regular traffic paint because of a loss of adhesion noted on portions of the roadway. This was the only substantial durability problem noted on the open-graded pavements. The other section restriped was the section of Interstate 75 in northern Kentucky where the average daily traffic (ADT) is about 100,000. This section was also restriped in late 1989 after three years in service and the need for restriping would be related to the high traffic volume. There were durability problems noted on some of the concrete bridge decks where there were sections having a loss in bond between the material and the concrete pavement. The durability of the material on the portland cement concrete bridges was inconsistent.

The evaluation period allowed the material to be exposed to the use of snowplows during three winters. Snowfall during these winters was not heavy, but the material had been subjected to snowplows. Some scraping of the top of the stripes was observed in isolated locations; however, observations indicated that snowplow operations had not damaged the material.

The ADT at most of the inspection locations was in the range of 20,000 to 30,000. There were some locations having an ADT of 10,000 to 15,000 and

observations were made at locations having an ADT of about 100,000. With the exceptions noted, the material remained durable after three years in service.

A problem was observed at the I 65 installation. One problem was related to "bubbles" which resulted in potholes in the line. No explanation for this problem was given by the contractor, but the problem most likely was related to the application process. None of the thermoplastic installations on the open-graded surfaces experienced this problem. The contractor was required to replace about 69 percent of the markings. This replacement was performed in 1989. The ADT of the section of road the thermoplastic markings were installed on was in the range of 40,000 to 80,000. There has also been some problem related to adhesion of the thermoplastic to the concrete pavement. While there has not been significant loss of material due to adhesion failure at this point in time, problem areas have been noted.

Reflectivity

Data were collected with the Mirolux 12 portable retroreflectometer (PRR) at six-month intervals over the three-year evaluation period. Data were collected on eight roadway sections (five having a hydrocarbon formulation and three having an alkyd formulation). Measurements were taken separately for the white edge lines, lane lines, and yellow edge lines.

Data from the various roadway sections were combined into the summary contained in Table 3. The data are listed in units of millicandelas and are listed in six-month intervals from six to 36 months in service. The PRR data show that the reflectivity of the stripes had been maintained adequately over the three-year evaluation period. This was confirmed by nighttime observations. The lowest readings were for the yellow edge line while the white edge line and lane line were not substantially different. The readings for the alkyd formulation were higher than for the hydrocarbon formulation during each period. The differences in the readings between the alkyd and hydrocarbon formulations have decreased over the evaluation period. All of the measurements have remained well above what would be considered a minimum acceptable value of about 100 millicandelas.

WATER-BASED PAINT

Appearance

The appearance of the yellow paint was judged to be good. The paint presented a bright color similar to a typical traffic paint. Colormeter measurements ranged from 30 to 50. The higher colormeter readings were obtained on the stripes which had the lower reflectivity measurements.

Durability

Most of the paint was restriped in 1989 after one year in service. Sufficient wear was noted that restriping was considered necessary. The exception was when it was used as a yellow edge line.

Reflectivity

The reflectivity of the stripes was maintained for the one year they were placed in service. A limited amount of PRR data revealed levels of 110-150 millicandelas for the yellow centerline and 110-230 millicandelas for the yellow edge line after one year in service.

PREFORMED TAPE

Appearance

Both the 3M and Prismo tapes maintained adequate appearance. The 3M tape was not as bright white as the Prismo tape but provided adequate daytime delineation. The 3M white tape had an average colormeter reading of 37 compared to 48 for the Prismo tape. The yellow colormeter measurements were very similar with an average of 34 for the 3M tape compared to 32 for the Prismo tape.

Durability

No durability problems were observed for the 3M tape after three years in service. It maintained adhesion with both the asphalt and portland cementconcrete surfaces. The ADT over the section of road where the 3M tape was installed was in the range of 90,000 to 100,000.

A durability problem was noted with the Prismo tape. The problem appeared to be related to the failure of adhesion between the tape and the portland cement concrete surface. It was the opinion of the inspector that the problem related to the thickness of the tape and the contraction and expansion of the portland cement concrete and the tape which resulted in the lack of adhesion. There was no indication of an application problem. A total of almost 5,000 feet, or about five percent of all the tape, was replaced in 1989. It was noted that only tape that had come completely or partially off the pavement was replaced and that more tape could have been removed by hand. The ADT over the section of road where the Prismo tape was installed was also in the range of 90,000 to 100,000.

Reflectivity

Measurements of the 3M tape obtained after three years in service indicated levels generally in the range of 200 to 250 millicandles for white and yellow edge lines. The manufacturer had a replacement warranty of 100 millicandles after 48 months in service. The measurements show that the tape will meet this minimum level on a roadway with an ADT of almost 100,000. The heavy traffic volume prevented a large amount of data from being collected on the lane lines; however, the data that were collected in the lane lines revealed reflectivity levels in the range of 160 to 200 millicandles after three years in service.

The Prismo tape maintained adequate reflectivity. After one to two years in service, measurements revealed a wide range in reflectivity. Measurements on the

white edge line ranged from around 100 to over 300 millicandles. The yellow edge line averaged slightly over 100 millicandles as did a few measurements obtained on the white lane line.

RECOMMENDATIONS

POLYESTER PAINT

The long-term evalation of polyester paint indicated that it was an effective durable lane delineation material. To maximize its effectiveness, it should be used on asphalt highways having an ADT of under 10,000. This requirement is met by almost 90 percent of all state-maintained highways so there is a potential for widespread use of this material.

Under typical circumstances, polyester paint should provide a service life of at least three years with the probability of up to five years in many instances. Given the contract costs of 7 to 8 cents per linear foot, this material would be cost-effective compared to typical traffic paint. Polyester paint would have to be installed by contract. Using this material on a few thousand miles of highways scattered across the various highway districts would enable Transportation Cabinet personnel to more effectively stripe the remaining highways each year.

EXTRUDED THERMOPLASTIC

The long-term evaluation of extruded thermoplastic as lane delineation on open-graded pavements indicated it to be an effective durable lane delineation material. While this evaluation dealt with open-graded pavements, use of extruded thermoplastics should be expanded to other bituminous pavements. However, extruded thermoplastics should not be used on portland cement concrete pavements. The cost for large-scale installations of approximately 20 cents per linear foot for four-inch lines may limit its use to higher volume highways. Either the hydrocarbon or alkyd formulation could be used, but the alkyd formulation has been observed to maintain a higher reflectivity.

An example of an appropriate use of extruded thermoplastics would be on the interstate system (except for portland cement concrete pavements). This material could also be used on high-volume urban arterials having an asphalt pavement.

WATER-BASED PAINT

This evaluation could not be used to classify this material as a durable lane delineation material. However, water-based paint can be used as an alternative to typical alkyd traffic paint.

PREFORMED TAPE

The long-term evaluation of the 3M 350 Series Stamark tape showed that it is an effective lane delineation material which could be included in Kentucky's pavement marking policy. However, the cost of this material of over one dollar per linear foot of four-inch line would limit its use. This material should be used on

high volume roads with portland cement concrete pavements. Sections of interstate having portland cement concrete pavements would be an appropriate use as well as high-volume urban arterials having portland cement concrete pavements.

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TABLE 1. PORTABLE RETROREFLECTOMETER DATA
(1986 POLYESTER CONTRACTS)

				PRR READING*					
				WHITE EDGE LINE			YELLOW CENTERLINE		
COUNTY	ROUTE	MP	ADT	1987	1988	1989	1987	1988	1989
Christian	US 41	21	2,860	230	230		140	150	
Christian	US 41	30	2,460	220			140		
Christian	US 41A	4	14,000	260			150		
Christian	US 41a	12	8,140	240			150		
Christian	KY 1682	2	3,090	210			150		
Daviess	US 60	13	11,800	120	80				
Daviess	KY 81	14	14,100				100	70	
Daviess	US 431	7	5,750	290	290		190	180	
Daviess	US 431	10	8,060	270	270		190	210	
Daviess	US 431	13	26,100	140	80		100	80	
Daviess	US 431	14	21,700	180	120		110	100	
Franklin	KY 151	2	3,290			240			200
Franklin	KY 1005	2	460		250			130	
Henderson	US 41	4	4,350			180			140
Henry	KY 153	6	2,660	200		220	110		120
Henry	KY 1359	2	1,150				130	160	150
Henry	KY 1606	1	1,410	200	210	190	140	130	100
Muhlenburg	US 62	16	10,500	210	190	140	120	130	110
Muhlenburg	KY 189	11	4,190	260	240	240	190	200	200
Ohio	US 231	14	7,760		230			180	
Shelby	KY 12	2	770	240	260	230	150	160	140
Shelby	KY 43	1	1,740	250	240	210	160	160	150
Shelby	KY 241	1	1,410	200	210	190	140	130	100
Shelby	KY 1005	1	580				120	110	90
Trimble	KY 625	11	610				160		
Union	US 60	11	5,890			250			150

*Millicandelas per square foot per foot candle.

TABLE 2. PORTABLE RETROREFLECTOMETER DATA
(1987 POLYESTER CONTRACTS)

				PRR READING*					
				WHITE EDGE LINE		WHITE LANE LINE		YELLOW CENTERLINE	
COUNTY	ROUTE	MP	ADT	1988	1989	1988	1989	1988	1989
Allen	KY 100	6	1,550						170
Bullitt	KY 245	5	5,500		230				140
Franklin	KY 151	2	3,290	230				200	
Hardin	KY 61	5	8,140	260	220	230	220	180	180
Hardin	I 65	100	26,600	270	250	260	240	200	190
Henderson	US 41	15	26,600	240		310		170	
Henderson	US 41	18	36,300			180		160	
Henderson	US 41	19	33,400	180		220		180	
Henry	KY 1899	1	330					170	130
Jefferson	KY 1699	1	5,970						180
Oldham	US 42	6	3,270		240				200
Oldham	US 42	13	1,810		270				190
Oldham	KY 329	5	1,390		230				150
Oldham	KY 393	10	1,010		220				180
Shelby	KY 1848	1	640	250	210			220	170
Taylor	US 68	7	12,900				200		170
Taylor	US 68	8	6,590		180				180
Taylor	KY 210	16	2,830		260		200		160
Warren	US 31W	18	11,000	220	180	250	210	170	140
Warren	US 231	12	24,300			110	140	130	130
Warren	US 231	15	8,950	160	140	170	180	170	150
Washington	KY 555	14	1,460	210				180	

* Millicandelas per square foot per foot candle.

TABLE 3. PORTABLE RETROREFLECTOMETER DATA FOR EXTRUDED THERMOPLASTIC MATERIALS.

TIME IN SERVICE (MONTHS)	PRR READING*					
	WHITE EDGE LINE		WHITE LANE LINE		YELLOW EDGE LINE	
	H**	A***	H	A	H	A
6	290	390	310	420	180	210
12	240	390	310	420	180	220
18	220	400	200	420	160	230
24	180	330	180	360	120	180
30	190	300	180	290	120	150
36	190	270	180	280	130	160

* Millicandles per square foot per foot candle.
** Hydrocarbon formulation.
*** Alkyd formulation.